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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09 867,467	05 31 2001	Hiroyuki Nagasawa	209291US0	6872

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EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

9

DATE MAILED: 12 04 2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/867,467

Applicant(s)

NAGASAWA ET AL.

Examiner

Matthew J Song

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-12 is/are pending in the application.
- 4a) Of the above claim(s) 9-11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-8 and 12 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4, 8.
- 4) ☐ Interview Summary (PTO-413) Paper No(s) ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-8 and 12, drawn to a method, classified in class 117, subclass 84.
- II. Claims 9-11, drawn to a product, classified in class 428, subclass 544.

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, such as one not requiring changing partial pressures of source gases.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Fredrick Vastine on 10/17/2002 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-8 and 12. Affirmation of this election must be made by applicant in replying to this Office action. Claims 9-11 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claim 2 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 2 recites, "continue for a prescribed period" in line 2, likewise in line 3; "prescribed" is indefinite.

7. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites, "referred to as condition 1 below" in line 18, which is indefinite. The examiner suggests defining "condition 1" in the claim as comprising the limitations desired for satisfying "condition 1", likewise for condition 2 in the last line of claim 1.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action.

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim Rejections - 35 USC § 103

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9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1, 2, 4 and 5 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Arya (US 4,718,947).

Arya discloses a method of making a superlattice, note entire reference, comprising C lattices deposited from a gaseous mixture of silane, methane and silane containing phosphine and D lattices containing, no carbon, deposited from a gaseous mixture of silane and phosphine (col 7, ln 1-67), where deposition of the C lattice reads on applicant's pc1 and the deposition of D lattice containing no Carbon reads on applicant's pc2. Arya also discloses the C and D lattices are deposited by DC glow discharge and other methods such as RF glow discharge, photo-CVD, CVD, sputtering, evaporation or any other conventional thin film deposition method also can be used (col 6, ln 1-67). Arya also discloses the C lattice is 18-30 angstroms thick and the D lattice is 22 angstroms thick (Table II) and the superlattice comprises 90-120 lattices (col 9, ln 1-67). Arya also discloses the gaseous mixture for forming the C lattice consists of 63 parts silane containing phosphine and 40 parts methane and the gaseous mixture for forming the D lattice consists of 63 parts silane containing phosphine, where the 63 parts of silane for the formation of both lattices reads on applicant's constant partial pressure of silicon source gas, ps.

Arya is silent to the partial pressure ratio of pc2/ps is within a range of less than one time the attachment coefficient ratio Ss/Sc. It is inherent to Arya to have a partial pressure ratio within

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a range of less than one time the attachment coefficient ratio S_s/S_c because Arya discloses a partial pressure of p_{c2} is 0, therefore the ratio is 0 which is inherently below the value of any ratio.

Ayra also is silent to the partial pressure ratio p_{c1}/p_s falls within a range of 1-10 times the attachment coefficient ratio S_s/S_c . It is inherent to Arya to have a partial pressure ratio p_{c1}/p_s within a range of 1-10 times the attachment coefficient ratio S_s/S_c because deposition of a silicon carbide layer occurs. A greater ratio will result in no SiC growth or less of a ratio will result in Si precipitation.

Further in any event, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Arya to have a partial pressure ratio within 1-10 times the attachment coefficient ratio S_s/S_c to grow a silicon carbide layer.

11 Claims 1-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Arya (US 4,718,947) in view of Golecki (US 5,225,032).

The Arya reference is relied on for the same reasons as stated, supra, and differs from the instant claims in the process conditions.

However, in a method for forming an epitaxial SiC film, note entire reference, Golecki teaches the stoichiometry of SiC film produced from two separate gaseous precursors for Si and for C will depend primarily on the ratio of the two corresponding flow rates, this reads on applicant's partial pressure, and also on the sticking coefficient, this reads on applicant's attachment coefficient, of each entity on the surface of the substrate at the deposition temperature and if excess Si or C atoms arrive at the surface defects result (col 3, ln 1-67). Golecki also

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teaches deposition of SiC on a silicon substrate at a temperature of 600-1000°C (col 4, ln 1-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Arya with Golecki's teaching of controlling the ratio of partial pressure to form an epitaxial SiC film free from defects (col 3, ln 15-30).

Referring to claim 3, Overlapping ranges are held to be obvious (MPEP 2144.05).

12. Claims 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Arya (US 4,718,947) in view of Golecki (US 5,225,032).

The combination of Arya and Golecki discloses all of the limitations of claim 6, as discussed previously, except the time during which the partial pressure of the carbon source gas is set to pc1 is 0.1-30 seconds and the time during which the partial pressure of the carbon source is set to pc2 is 0.1-30 seconds. Arya teaches the C and D lattice have a thickness of 18-30 angstroms 22 angstroms, respectively. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Arya and Golecki to have a time of 0.1-30 seconds for pc1 and a time of 0.1-30 seconds for pc2 to produce a lattice within the specified thickness, as taught by Arya.

13. Claims 3-4 rejected under 35 U.S.C. 103(a) as being unpatentable over Arya (US 4,718,947) in view of Nagasawa et al (US 5,390,626).

Arya discloses all of the limitations of claim 3, as discussed previously, except the silicon carbide is formed on a substrate, the temperature of which is not less than 900°C.

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In a method of forming silicon carbide, note entire reference, Nagasawa et al teaches a low pressure CVD forming a silicon carbide film using SiH_2Cl_2 and C_2H_2 as source gases. Nagasawa et al also teaches a substrate temperature of 800-1000°C and the use of a substrate with a diameter of 5 inches or less (col 3, ln 1-67; col 5, ln 1-40). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Arya with Nagasawa et al to form a SiC film with excellent uniformity in film properties and to increase mass productivity (col 2, ln 1-67). Overlapping ranges are held to be obvious (MPEP 2144.05).

14. Claims 7-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Arya (US 4,718,947) in view of Golecki (US 5,225,032) as applied to claims 1-5 above, and further in view of Sugiyama et al (US 5,964,944).

The combination of Arya and Golecki discloses all of the limitations of claim 7, as discussed previously, except the silicon carbide is employed as a seed crystal and silicon carbide is formed on the seed crystal by vapor phase epitaxy, sublimation recrystallization or liquid deposition.

In a method of producing silicon carbide single crystals by vapor phase epitaxy, note entire reference, Sugiyama et al teaches using large silicon carbide seed crystals, as large as 3-4 inches in diameter, in the production of a large size silicon carbide single crystal (col 5, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Arya and Golecki with Sugiyama et al to produce larger silicon carbide crystals useful in the semiconductor industry at a low cost (col 1-67; col 2, ln 1-67). In

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regards to applicant's bore of 4-6 inches; overlapping ranges are held to be obvious (MPEP 2144.05).

15. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Arya (US 4,718,947) in view of Golecki (US 5,225,032) as applied to claims 1-5 above, and further in view of Gardner (US 3,630,678).

The combination of Arya and Golecki discloses all of the limitations of claim 12, as discussed previously, except the silicon carbide is employed as a seed crystal and diamond and/or gallium nitride is formed on the seed crystal.

In a process for growing diamond, note entire reference, Gardner teaches a diamond grown on a silicon carbide seed with improved crystallinity grown using carbon containing gases (col 7, ln 1-67; col 1, ln 1-67; Claim 1). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Arya and Golecki with Gardner to produce diamonds, which are useful as abrasives and semiconductors (col 1, ln 1-25).

Conclusion

16 The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Stephani et al. (US 5,989,340) teaches a CVD process for forming polycrystalline silicon carbide at 950°C using methane, propane or butane as a carbon source and using SiH₄, SiHCl₃ or SiH₂Cl₂ as a silicon source (col 5).

Kong et al. (US 5,200,022) teaches forming silicon carbide using SiH_4 and C_2H_2 with a flow ratio of 2 (col 10).

Nagasawa et al (US 5,254,370) teaches pulsing silicon and carbon sources for a period of 2-60 seconds for the formation of a silicon carbide film (col 3-4).

Kordina et al (US 5,704,985) teaches growing SiC boules using CVD (abstract).

Tay et al (US 5,296,258) teaches at temperatures greater than 775°C SiC deposited by CVD are C rich and below 775°C SiC is Si rich (col 6, ln 1-67)

Kenichi (Abstract of JP 05-032485) teaches supplying reactant gases until the amount of reaction gases is enough to generate a thin film of the surface having a lower attachment coefficient.

17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661

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Matthew J Song
Examiner
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MJS
November 26, 2002

A handwritten signature in black ink, appearing to read 'Matthew J Song', written over a faint horizontal line.

ROBERT M. DE WIT
PRESIDENT